Carbon Capture and Sequestration: A Primer

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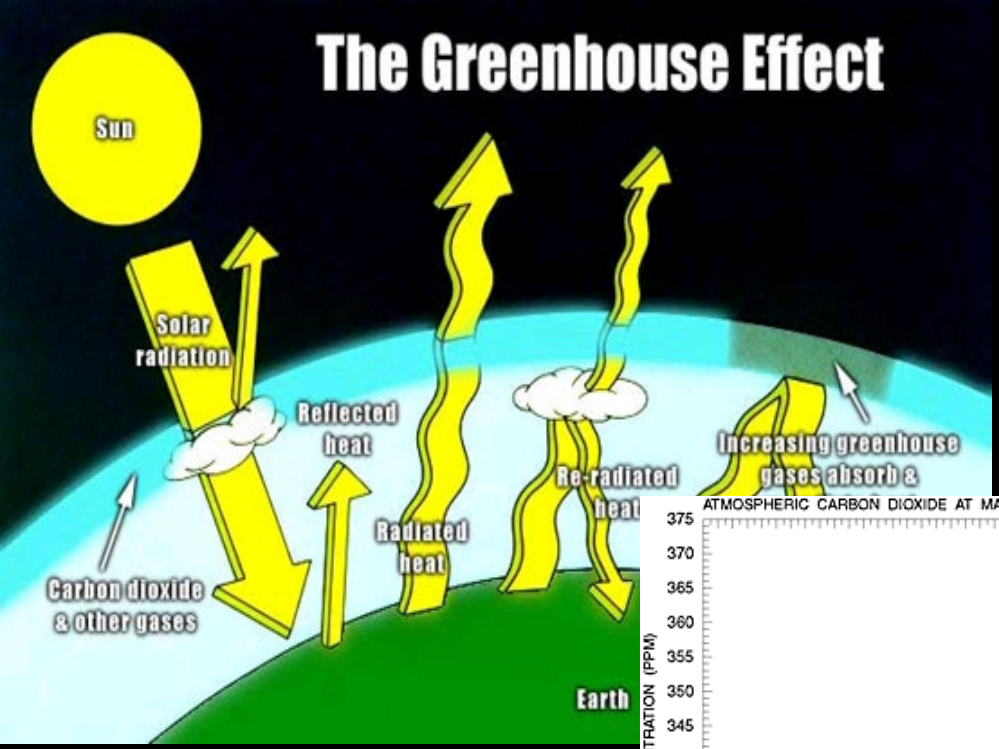
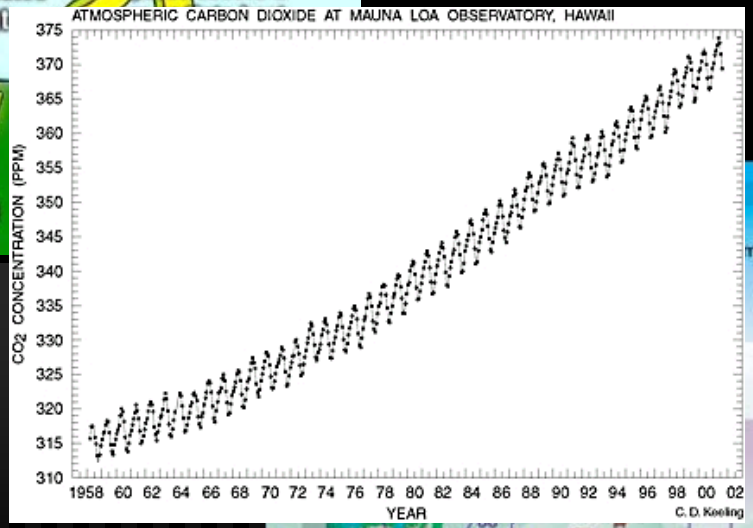
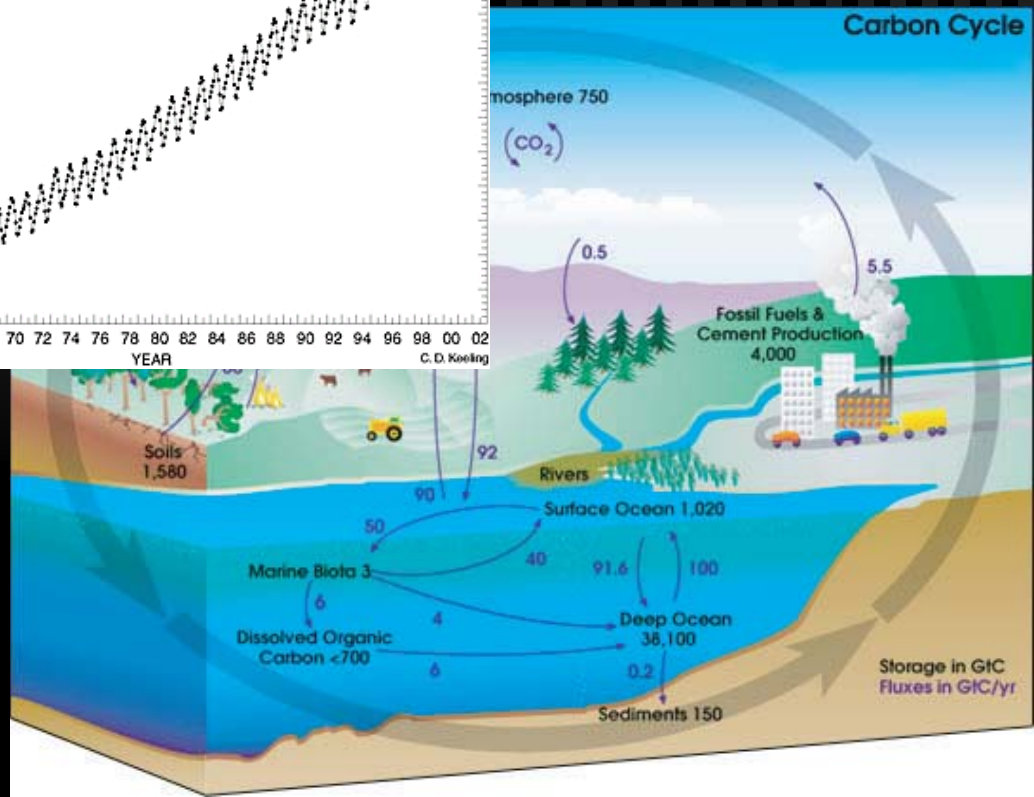
Presentation Summary

- Motivation: climate change mitigation
- CO_2 sequestration technology
- Status of proposed rule; Public health implications
- Current efforts relating to sequestration



Unmitigated CO_2 emissions…



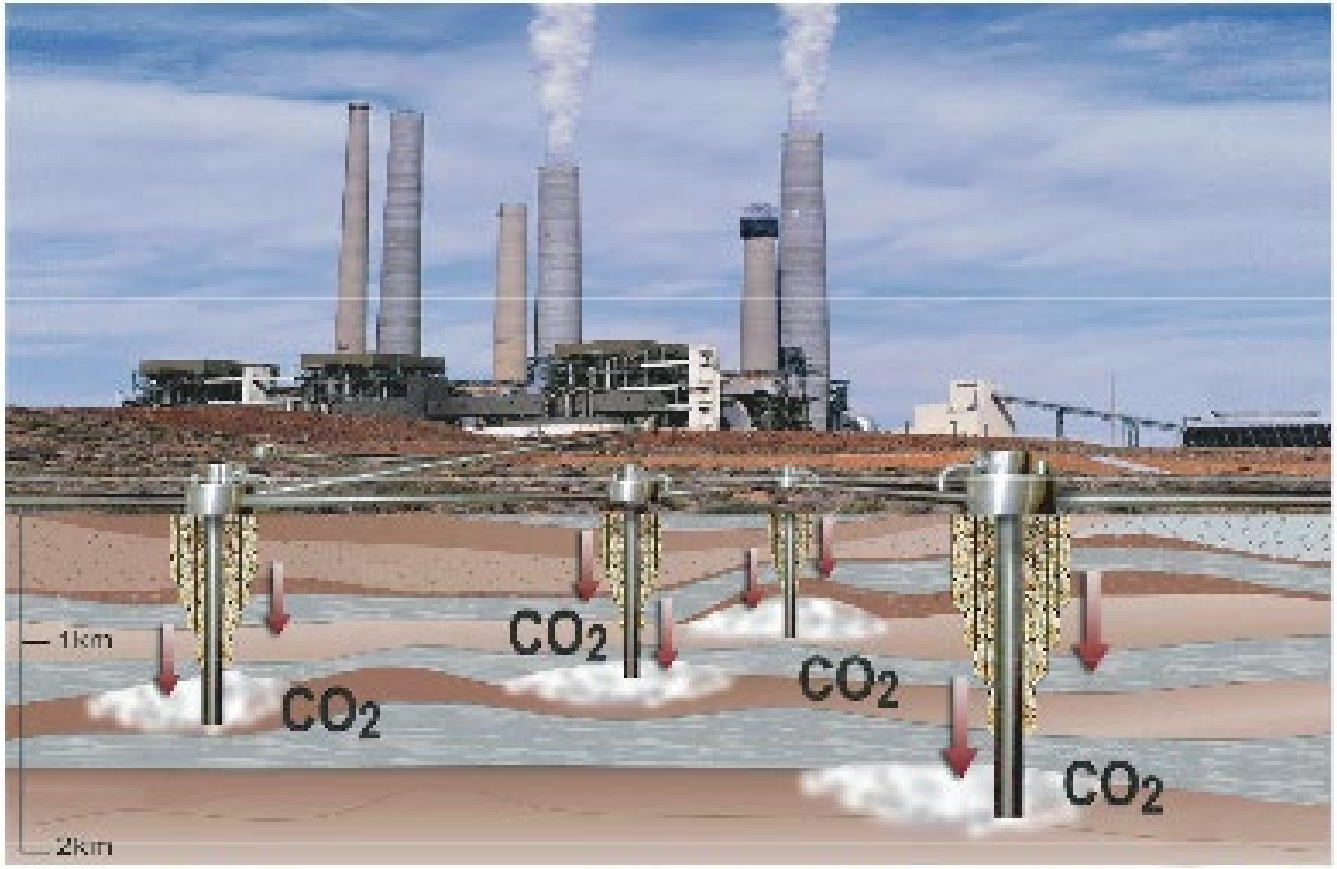


…are unsustainable.

What Can Be Done to Mitigate Greenhouse Gas Levels?

- Goal: stabilize CO_2 at 500 ppm in 50 years
- Requires holding emissions near the present level of 7 GtC/yr (BAU by 2055: 14 GtC/yr)
- **1 GtC/yr savings (1/7th necessary): Carbon capture and sequestration at 800 one GW coal power plants**
  - = Increase fuel economy for two billion cars from 30 to 60 mpg
  - = Increase wind power capacity by 50 times over current levels by adding 2,000,000 more 1MW windmills
  - = Double the current capacity of nuclear power, displacing coal generated power

Carbon Dioxide Capture and Storage Involves 4 Steps



Capture → **Compression** → **Pipeline Transport** → **Underground Injection**

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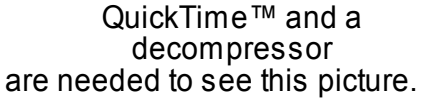
Basic Concepts

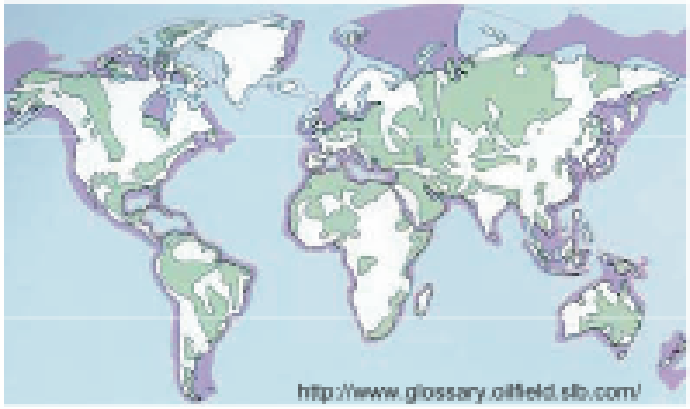


Roger Aines, LLNL

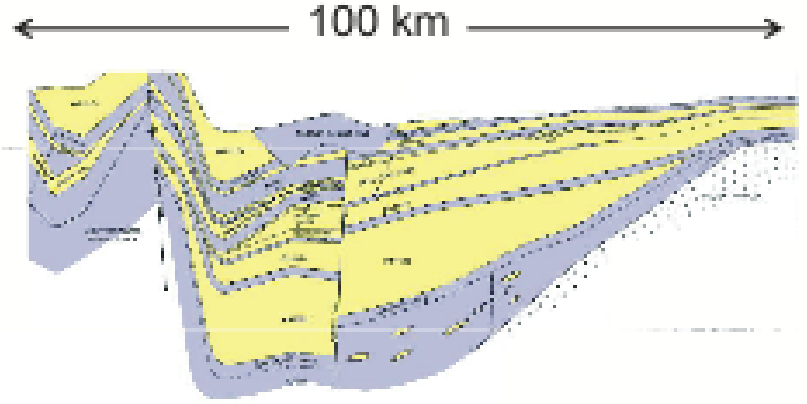
Secondary Trapping Over Time

What Types of Rock Formations are Suitable for Geological Storage?

Rocks in deep sedimentary basins are suitable for CO_2 storage.



Map showing world-wide sedimentary basins



Northern California Sedimentary Basin

Sandstone

Example of a sedimentary basin with alternating layers of sandstone and shale.

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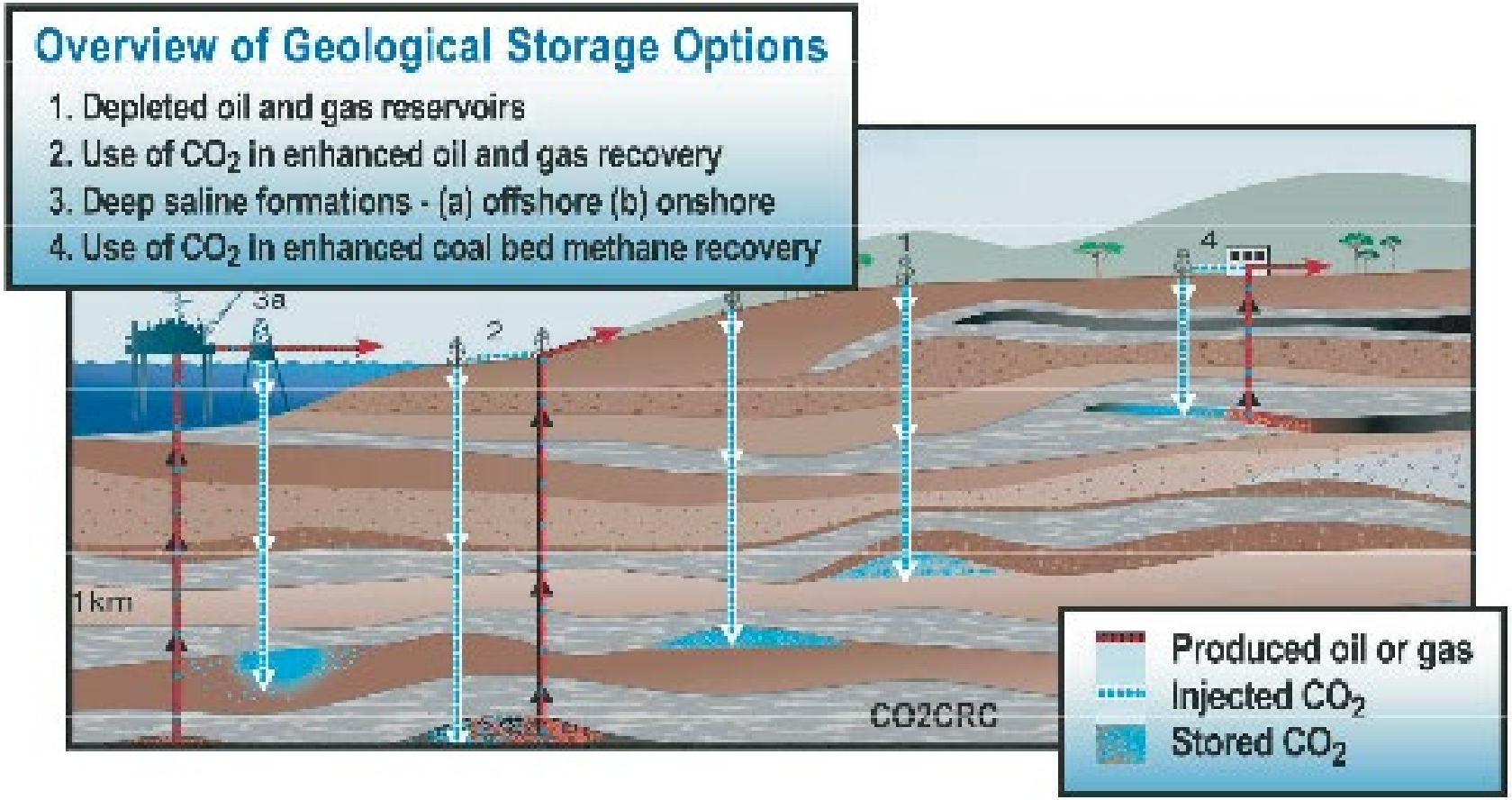
Options for Geological Storage



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Storage Resources

- Oil and Gas Reservoirs could potentially store about 60 years of current emissions from power generation.
- Unminable coal formations…80 years of current emissions.
- Saline aquifers…1000 years of current emissions.

(national and CA)

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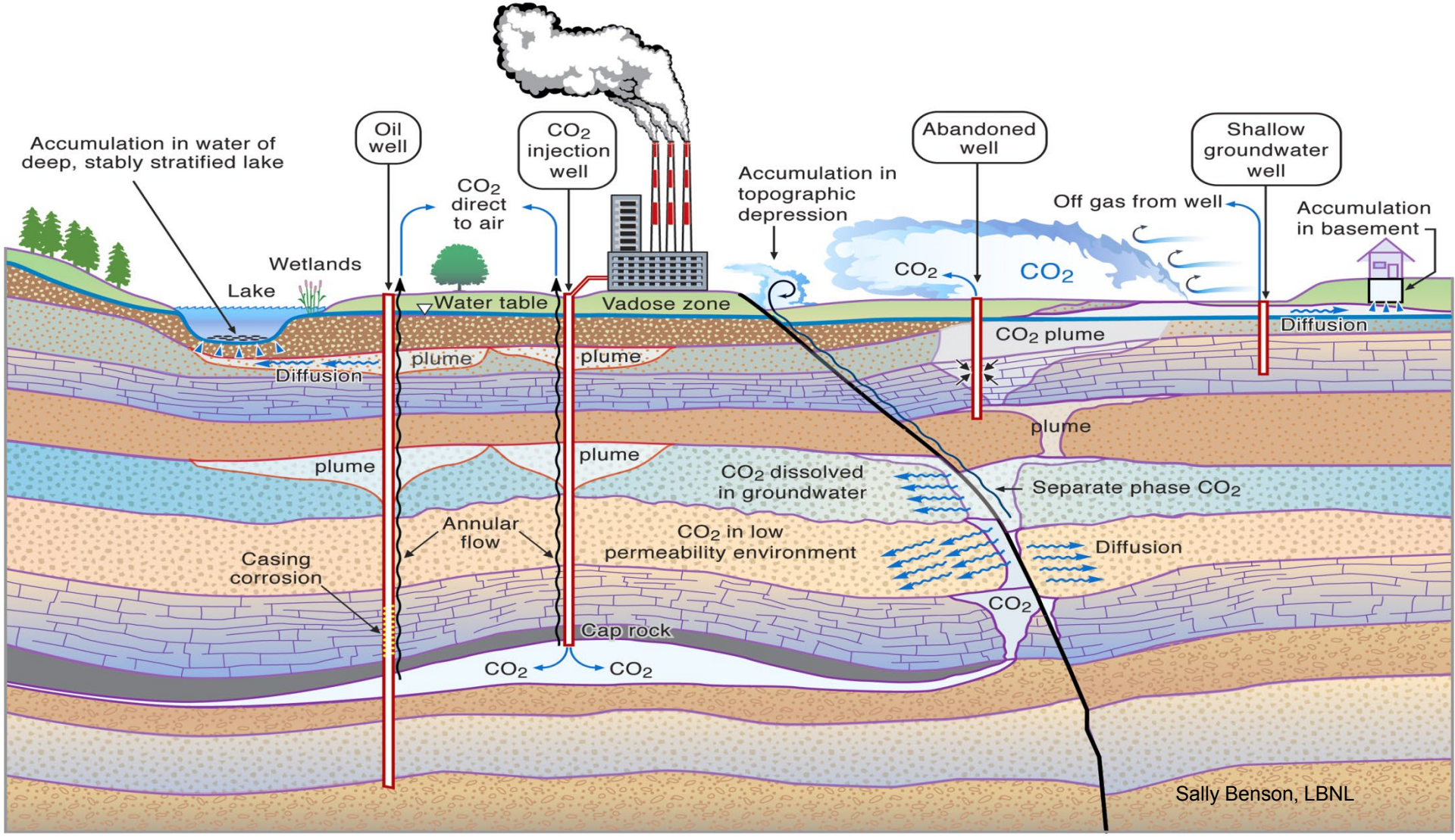
Expert Opinion on Storage Safety

Wells as Integrity Hazards

Potential Leakage Pathways

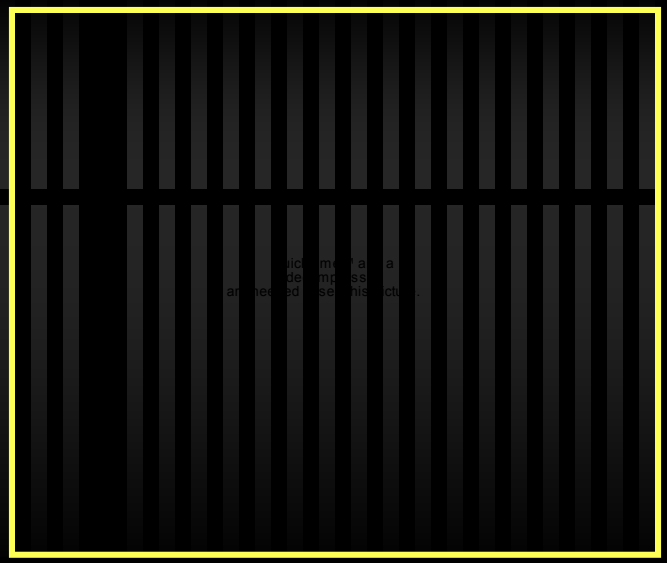


QuickTime™ and a
decompressor
are needed to see this picture.

Current Actions

- Congress funding DOE pilot studies
  - WESTCARB, one of 7 national DOE partnerships characterize regional carbon sequestration opportunities and conduct technology validation field tests.

    (The CEC manages WESTCARB, is a major co-funder.)
  - EPA R9 also member of Southwest Regional Partnership



Current Actions

October 2, 2009

Secretary Chu Announces First Awards from $1.4 Billion for Industrial Carbon Capture and Storage Projects

Washington, DC--U.S. Energy Secretary Steven Chu today announced the first round of funding from $1.4 billion from the American Recovery and Reinvestment Act for the selection of 12 projects that will capture carbon dioxide from industrial sources for storage or beneficial use.

EPA Policy Decisions

- 2006 – EPA memo documented that:
  - CO_2 sequestration by injection falls under the UIC program of Safe Drinking Water Act
  - CO_2 injection related to pilot sequestration projects should be permitted as Class V experimental technology wells

EPA Policy Decisions

- July 5, 2008: Class VI Rule Proposed

  "Federal Requirements Under the Underground Injection Control (UIC) Program for Carbon Dioxide (CO2) Geologic Sequestration (GS) Wells"
- Technical criteria for permitting GS wells to protect USDWs under SDWA using modified UIC Framework, including:
  - Geologic site characterization
  - Corrective action (nearby wells)
  - Well construction, operation, testing
  - Monitoring
  - Well plugging
  - Post-injection site care
  - Site closure
- Received 365 public comments (151 unique)

EPA Policy Decisions

- August 31, 2009: Notice of Data Availability and Request for Comment (NODA)
  - Presents new data and information and requests public comment on related issues that have evolved in response to comments on the original proposal.
  - Contains:
    - Preliminary field data from the DOE-sponsored Regional Carbon Sequestration Partnership projects
    - Results of GS-related studies conducted by LBNL
    - Additional GS-related research
    - Discusses comments
    - Proposes variation on requirements below lowermost USDW
  - End of Comment Period: October 15, 2009
  - **Anticipated Final Rule: 2011**

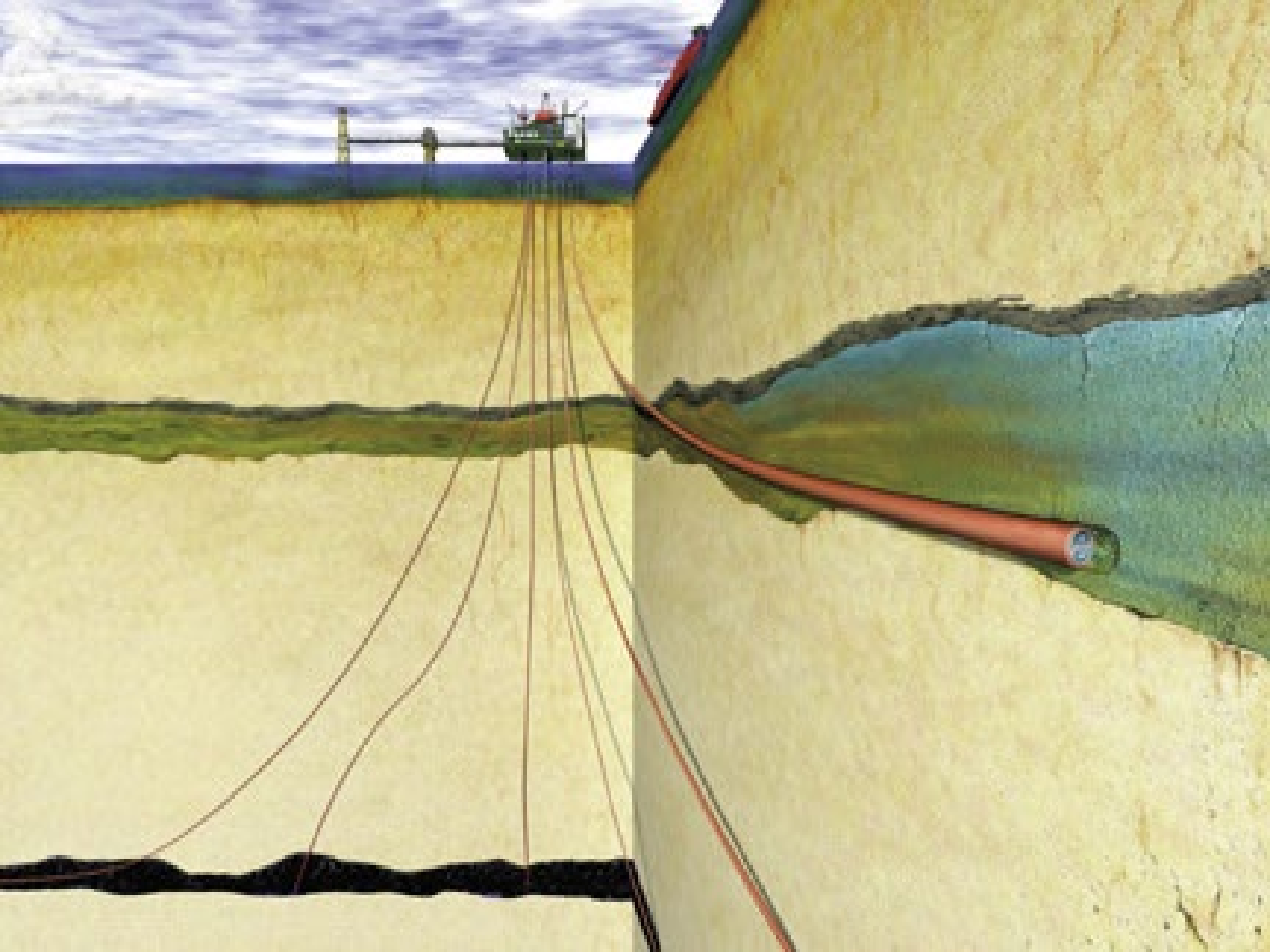
NODA PWS Implications

- Waiver for injection where very deep USDWs
- Unlikely to impact California/Region 9
- Information submitted to UIC and PWSS, requires approval by both offices
- Subject to local notice and public hearing

Current Sequestration Projects

Sleipner Field, Norway

- Location: Norwegian North Sea
- Project start date: 1996
- 2800 ton/day CO_2 storage in saline aquifer (1M t CO_2/year)
  - World's 1st commercial-scale storage of CO_2 for mitigation of climate change.
  - Injected into a large, deep saline reservoir 800M below the bed of the North Sea
- Monitoring results:
  - Confirming that CO_2 storage in deep saline reservoirs is a safe and reliable option
  - Supplying data to validate reservoir simulation models
  - Applicable in the planning of future CO_2 storage projects in other parts of the world



Region 9 (DOE/WC) CO_2 GS Projects

- AZ Cholla (Flagstaff)
  - 2,000 tons over < 1 month (equivalent to 1,000 MW coal-fired power plant emissions over 2.2 hours); monitored 3-5 months
  - Permitted 3/09; Update: injection zone inadequate permeability; will plug well, potentially move to new location
- Kimberlina (Bakersfield)
  - 250,000 tons/year for 4 years (zero-emissions plant)
  - Funding issues; LBNL efforts to be assigned to Shell
- Shell/C6 (Fairfield)
  - 2,000-6,000 tons over 1-2 months; monitoring well
  - Potential for commercial scale (DOE Grant -- $3M)
  - Technical review